PATENT ABSTRACTS OF JAPAN

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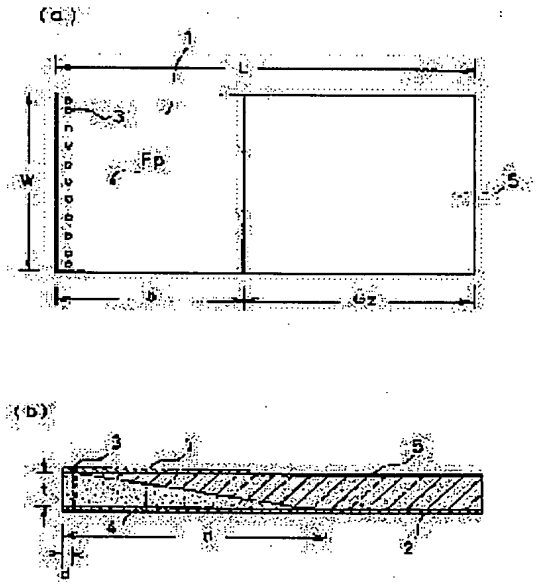
(54) OBLIQUE TWO-LAYER DIELECTRIC CONSTITUTION MICROSTRIP ANTENNA

(57)Abstract:
PURPOSE: To provide a microstrip antenna whose antenna length can be shortened and whose characteristic of radiation efficiency and band width can be improved.
CONSTITUTION: A first dielectric 4 is formed on a ground plate 2 so that thickness becomes gradually thin from the end part of a feed point Fp-side of a patch 1 and the ground plate 2, and a second dielectric 5 is formed on a patch 1-side so that thickenss becomes gradually thick from the end part of the feed point Fp-side of the patch 1 and the ground plate 2 toward the other end of the ground plate 2. The first and second dielectrics 4 and 5 are formed so that the whole thicknesses (t) of them become equal, and the patch 1 and the ground plate 2 are formed on the external side.



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CLAIMS

[Claim(s)]
[Claim 1] The dielectric layer which each other was joined and was formed in the field where the dielectric which is two from which a dielectric constant differs inclined to those thickness directions, the radiation patch formed in one field of said dielectric layer, and the slanting bilayer dielectric configuration microstrip antenna which has the grand layer formed in the field of another side of said dielectric layer.
[Claim 2] The slanting bilayer dielectric configuration microstrip antenna of said dielectric according to claim 1 which carries out the laminating of two or more dielectric materials, respectively so that one [those] edge may incline to the thickness direction of said dielectric.

[Translation done.]

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to a microstrip antenna.
[0002]
[Description of the Prior Art] Conventionally, the end of two electric conduction plates short-circuits that from which a dielectric constant is the structure where the dielectric of homogeneity was put between two electric conduction plates, i.e., radiation patches and grand plates, and, as for the microstrip antenna, constituted the die length of a radiation patch to lambda/4, and the cross section is formed in the typeface of abbreviation KO. This microstrip antenna has the advantage that it can constitute in a thin form, and is

useful to a small wireless device.
[0003]
[Problem(s) to be Solved by the Invention] However, generally the conventional microstrip antenna has the fault that a band is narrow, low [radiant efficiency]. Antenna length will become long, if a dielectric with a low dielectric constant epsilon is used in order to raise radiant efficiency. Moreover, thickness must be increased in order to extend a band. Although antenna length can be shortened if a dielectric constant epsilon uses a high dielectric in order to make a dimension small, there is a trouble that radiant efficiency becomes low and bandwidth becomes narrow.
[0004] Therefore, this invention aims at offering the microstrip antenna which can shorten antenna length with the same radiant efficiency as the former, or can improve properties, such as radiant efficiency and bandwidth, also with the same dimension as the former.
[0005]
[Means for Solving the Problem] In order to attain the above-mentioned purpose, it is joined mutually, and a dielectric layer is formed and consists of this inventions in the field where the dielectric which is two from which a dielectric constant differs inclined to those thickness directions. That is, the dielectric layer which each other was joined and was formed in the field where the dielectric which is two from which a dielectric constant differs according to this invention inclined to those thickness directions, the radiation patch formed in one field of said dielectric layer, and the slanting bilayer dielectric configuration microstrip antenna which has the grand layer formed in the field of another side of said dielectric layer are offered.
[0006]
[Function] Since this invention has the above-mentioned configuration, it can also improve bandwidth, without being able to improve effectiveness effectually, and being able to shorten the die length as compared with the antenna which has the single dielectric of the same dielectric constant as an equivalence dielectric constant, and increasing thickness, even if it uses a dielectric with a high dielectric constant for a part.
[0007]
[Example] Hereafter, the example of this invention is explained with reference to a drawing. The top view and drawing 1 (b) which show one example of the microstrip antenna concerning this invention drawing 1 (a) The side elevation and drawing 2 which show the antenna of drawing 1 (a) The explanatory view and drawing 3 which show the manufacture approach of the microstrip antenna of drawing 1 The side elevation and drawing 4 which show the microstrip antenna formed by the manufacture approach of drawing 2 The side elevation and drawing 5 which show various microstrip antennas The graph and drawing 7 which show the gain of each antenna of drawing 4 [drawing 6 / which show the fractional-bandwidth property of each antenna of drawing 4 according to antenna length / the graph and drawing 6] according to antenna length are a graph which shows the radiant efficiency of each antenna of drawing 4 according to antenna length.
[0008] In drawing 1 , the antenna of this example is a rectangular microstrip antenna of quarter-wave length, the width of face W of the radiation patch 1 and its width of face W of the grand plate 2 are equal, and the die length of patch 1 is constituted so that the die length of b and the grand plate 2 may be set to L (>b) and spacing may be set to t. The patch 1 and the grand plate 2 were formed by the copper foil whose thickness is 18

micrometers, and the edge by the side of the feeding point Fp has short-circuited them through two or more through holes 3. In addition, in this example, only distance d separates a through hole 3 from the edge of patch 1 and the grand plate 2, along the cross direction of patch 1 and the grand plate 2, a diameter is formed by 0.3mm and spacing is formed by 1.8mm. Although the grand plate 2 has connected with the patch 1 too hastily through the through hole 3 in this example, the copper foil by the side of the feeding point Fp may be formed and connected with horseshoe-shaped too hastily.

[0009] From the edge by the side of the feeding point Fp of patch 1 and the grand plate 2, the 1st dielectric 4 is formed on the grand plate 2 so that thickness may become thin gradually toward other edges of the distance Ld (b<Ld<L) direction, and from the edge by the side of the feeding point Fp of patch 1 and the grand plate 2, the 2nd dielectric 5 is formed in the patch 1 side so that thickness may become thick gradually toward the other end of the grand plate 2. That is, the 1st and 2nd dielectric 4 and 5 is formed so that the whole thickness t may become equal.

[0010] Next, the manufacture approach of a microstrip antenna is explained with reference to drawing 2 and drawing 3 . first, the inside of a reactor with a decompression device -- PPO -- 100g and a styrene butadiene copolymer (Asahi Chemical Industry Co., Ltd. --) a brand name "tough PUREN A" -- 50g and triallyl isocyanurate (Nippon Kasei Chemical Co., Ltd. --) a brand name "TAIC" -- 50g, 2, the 5-dimethyl -2, and 5-G (tert-butyl par oxine) hexane -3 (Nippon Oil & Fats Co., Ltd. --) The brand name "par hexyne 25B" was blended by 2g, and the trichloroethylene (Toagosei chemical-industry incorporated company, brand name "trichlene") was blended at a rate of 700g, it agitated enough until it became a homogeneity solution, and the 1st PPO system resin constituent solution was obtained.

[0011] Moreover, to the 1st 500g PPO system resin constituent solution obtained like the above-mentioned approach, the mean diameter added 250g of titanium-dioxide powder which is 1-2 microns, agitated further, distributed homogeneity, and obtained the 2nd PPO system resin constituent solution.

[0012] Next, it was immersed in the 1st and 2nd solution of the above for a while, respectively, glass fabrics were taken out from each solution, it dried for about 20 minutes by 120-degreeC for about 10 minutes by 50-degreeC, and the prepreg ingredients a and b of the glass-fabrics base material with which the trichloroethylene was completely removed and two kinds of PPO system resin constituents sank in were obtained. Here, the resin content {= impregnating resin weight x100(%)/(glass-fabrics weight + impregnating resin weight)} was 50%, the dielectric constant was about 3.5, as for the prepreg ingredient b, the resin content was about 80% and the dielectric constant of the prepreg ingredient a was about 10.5.

[0013] As shown in drawing 2 and drawing 3 , the laminating of these prepreg ingredients a and b was carried out so that one [those] edge might incline to the thickness direction of an antenna. That is, the laminating was carried out as shown in drawing 3 in detail so that one edge of the prepreg ingredient a-2 to a-12 and the prepreg ingredient b-2 to b-12 might counter in the same field, respectively, and so that the opposite location of the longitudinal direction in drawing 3 might shift along the thickness direction t of an antenna. And the laminating of the prepreg ingredient a-1 and a-13 was carried out all over the patch 1 side and the grand plate 2 side, respectively, subsequently to the prepreg ingredient a-1 and the outside of a-13, the laminating of the

copper foil 1a and 1b was carried out, respectively, heating pressurization was carried out on 180-degreeC and 30kg/cm2 conditions, and the patch 1 and the grand plate 2 were formed. In addition, the inclination distribution length Ld of the opposite section of about 2mm and a prepreg ingredient of thickness t of this whole laminate was 60mm. In addition, after the condition of drawing 3 is completed, a garbage can be cut and can obtain the antenna of a desired geometry.

[0014] Next, the comparison result of the property of the antenna of this example and the conventional antenna is explained. In drawing 4 , Antenna A is the conventional example for which the dielectric constant epsilon used the dielectric of 3.5, and Antennas B are other conventional examples for which the dielectric constant epsilon used the dielectric of 10.5. Therefore, although Antenna B can shorten antenna length to Antenna A, radiant efficiency becomes low and bandwidth becomes narrow. In drawing 1 , using the thing of 3.5 as the 1st dielectric 4, a dielectric constant epsilon shows the case where a dielectric constant epsilon uses the thing of 10.5 as the 2nd dielectric 5, and, as for Antenna C, a dielectric constant epsilon shows the case where a dielectric constant epsilon uses the thing of 3.5 as the 2nd dielectric 5, using the thing of 10.5 as the 1st dielectric 4, in drawing 1 , as for Antenna D.

[0015] Contrary to the case of the antennas C and D as shown in drawing 1 , Antenna E moreover, the 1st dielectric 4 From the edge by the side of the feeding point Fp of patch 1 and the grand plate 2, it is formed on patch 1 so that thickness may become thin gradually toward other edges of the distance Ld direction. The 2nd dielectric 5 From the edge by the side of the feeding point Fp of patch 1 and the grand plate 2, it is formed in the grand plate 2 side so that thickness may become thick gradually toward the other end of the grand plate 2. Arrangement of the two-sort dielectric of Antenna E becomes reverse, and Antenna F is formed. It can manufacture by the approach as shown in drawing 2 and drawing 3 similarly [in the case of these antennas E and F].

[0016] When the fractional bandwidth according to the antenna length L, and gain and radiant efficiency were measured using the antennas A and B of antenna C-F of the example of this invention, and the conventional single dielectric, the result as shown in drawing 5 - drawing 7 , respectively was obtained. With Antennas E and F, equivalence specific inductive capacity becomes low compared with Antennas C and D. Moreover, gain and radiant efficiency fall as compared with Antennas E and F, and, as for Antennas C and D, a band spreads. Especially, as for Antenna E, the antenna length L has the property that specific inductive capacity is equivalent to the conventional antenna A of 3.5, in 80mm or less.

[0017] That is, since gain can be improved by about 0.3-4dB by 2mm in thickness in the case of the same antenna length L, and the antenna length L can be short constituted about several mm to the conventional quarter-wave length microstrip antenna A when it is the same gain, it is effective in a pocket-size small wireless device.

[0018]

[Effect of the Invention] Without using a uniform single dielectric layer with a high dielectric constant according to this invention, since two kinds of dielectrics with which dielectric constants differ were joined in the inclined plane as explained above, antenna length can be shortened and properties, such as radiant efficiency and bandwidth, can be improved.

[Translation done.]

TECHNICAL FIELD

[Industrial Application] This invention relates to a microstrip antenna.

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PRIOR ART

[Description of the Prior Art] Conventionally, the end of two electric conduction plates short-circuits that from which a dielectric constant is the structure where the dielectric of homogeneity was put between two electric conduction plates, i.e., radiation patches and grand plates, and, as for the microstrip antenna, constituted the die length of a radiation patch to lambda/4, and the cross section is formed in the typeface of abbreviation KO. This microstrip antenna has the advantage that it can constitute in a thin form, and is useful to a small wireless device.

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EFFECT OF THE INVENTION

[Effect of the Invention] Without using a uniform single dielectric layer with a high dielectric constant according to this invention, since two kinds of dielectrics with which dielectric constants differ were joined in the inclined plane as explained above, antenna length can be shortened and properties, such as radiant efficiency and bandwidth, can be improved.

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TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] However, generally the conventional microstrip antenna has the fault that a band is narrow, low [radiant efficiency]. Antenna length will become long, if a dielectric with a low dielectric constant epsilon is used in order to raise radiant efficiency. Moreover, thickness must be increased in order to extend a band. Although antenna length can be shortened if a dielectric constant epsilon uses a high dielectric in order to make a dimension small, there is a trouble that radiant efficiency becomes low and bandwidth becomes narrow.
[0004] Therefore, this invention aims at offering the microstrip antenna which can shorten antenna length with the same radiant efficiency as the former, or can improve properties, such as radiant efficiency and bandwidth, also with the same dimension as the former.

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MEANS

[Means for Solving the Problem] In order to attain the above-mentioned purpose, it is joined mutually, and a dielectric layer is formed and consists of this inventions in the field where the dielectric which is two from which a dielectric constant differs inclined to those thickness directions. That is, the dielectric layer which each other was joined and was formed in the field where the dielectric which is two from which a dielectric constant differs according to this invention inclined to those thickness directions, the radiation patch formed in one field of said dielectric layer, and the slanting bilayer dielectric configuration microstrip antenna which has the grand layer formed in the field of another side of said dielectric layer are offered.
[0006]

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OPERATION

[Function] Since this invention has the above-mentioned configuration, it can also improve bandwidth, without being able to improve effectiveness effectually, and being able to shorten the die length as compared with the antenna which has the single dielectric of the same dielectric constant as an equivalence dielectric constant, and increasing thickness, even if it uses a dielectric with a high dielectric constant for a part.

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* NOTICES *

EXAMPLE

[Example] Hereafter, the example of this invention is explained with reference to a drawing. The top view and drawing 1 (b) which show one example of the microstrip antenna concerning this invention drawing 1 (a) The side elevation and drawing 2 which show the antenna of drawing 1 (a) The explanatory view and drawing 3 which show the manufacture approach of the microstrip antenna of drawing 1 The side elevation and drawing 4 which show the microstrip antenna formed by the manufacture approach of drawing 2 The side elevation and drawing 5 which show various microstrip antennas The graph and drawing 7 which show the gain of each antenna of drawing 4 [drawing 6 / which show the fractional-bandwidth property of each antenna of drawing 4 according to antenna length / the graph and drawing 6] according to antenna length are a graph which shows the radiant efficiency of each antenna of drawing 4 according to antenna length.
[0008] In drawing 1 , the antenna of this example is a rectangular microstrip antenna of quarter-wave length, the width of face W of the radiation patch 1 and its width of face W of the grand plate 2 are equal, and the die length of patch 1 is constituted so that the die length of b and the grand plate 2 may be set to L (>b) and spacing may be set to t. The patch 1 and the grand plate 2 were formed by the copper foil whose thickness is 18 micrometers, and the edge by the side of the feeding point Fp has short-circuited them through two or more through holes 3. In addition, in this example, only distance d separates a through hole 3 from the edge of patch 1 and the grand plate 2, along the cross direction of patch 1 and the grand plate 2, a diameter is formed by 0.3mm and spacing is formed by 1.8mm. Although the grand plate 2 has connected with the patch 1 too hastily through the through hole 3 in this example, the copper foil by the side of the feeding point Fp may be formed and connected with horseshoe-shaped too hastily.
[0009] From the edge by the side of the feeding point Fp of patch 1 and the grand plate 2, the 1st dielectric 4 is formed on the grand plate 2 so that thickness may become thin gradually toward other edges of the distance Ld (b<Ld<L) direction, and from the edge by the side of the feeding point Fp of patch 1 and the grand plate 2, the 2nd dielectric 5 is formed in the patch 1 side so that thickness may become thick gradually toward the other end of the grand plate 2. That is, the 1st and 2nd dielectric 4 and 5 is formed so that the whole thickness t may become equal.
[0010] Next, the manufacture approach of a microstrip antenna is explained with reference to drawing 2 and drawing 3 . first, the inside of a reactor with a decompression device -- PPO -- 100g and a styrene butadiene copolymer (Asahi Chemical Industry Co., Ltd. --) a brand name "tough PUREN A" -- 50g and triallyl isocyanurate (Nippon Kasei Chemical Co., Ltd. --) a brand name "TAIC" -- 50g, 2, the 5-dimethyl -2, and 5-G (tert-butyl par oxine) hexane -3 (Nippon Oil & Fats Co., Ltd. --) The brand name "par hexyne 25B" was blended by 2g, and the trichloroethylene (Toagosei chemical-industry

incorporated company, brand name "trichlene") was blended at a rate of 700g, it agitated enough until it became a homogeneity solution, and the 1st PPO system resin constituent solution was obtained.

[0011] Moreover, to the 1st 500g PPO system resin constituent solution obtained like the above-mentioned approach, the mean diameter added 250g of titanium-dioxide powder which is 1-2 microns, agitated further, distributed homogeneity, and obtained the 2nd PPO system resin constituent solution.

[0012] Next, it was immersed in the 1st and 2nd solution of the above for a while, respectively, glass fabrics were taken out from each solution, it dried for about 20 minutes by 120-degreeC for about 10 minutes by 50-degreeC, and the prepreg ingredients a and b of the glass-fabrics base material with which the trichloroethylene was completely removed and two kinds of PPO system resin constituents sank in were obtained. Here, the resin content {= impregnating resin weight x100(%)/(glass-fabrics weight + impregnating resin weight)} was 50%, the dielectric constant was about 3.5, as for the prepreg ingredient b, the resin content was about 80% and the dielectric constant of the prepreg ingredient a was about 10.5.

[0013] As shown in drawing 2 and drawing 3 , the laminating of these prepreg ingredients a and b was carried out so that one [those] edge might incline to the thickness direction of an antenna. That is, the laminating was carried out as shown in drawing 3 in detail so that one edge of the prepreg ingredient a-2 to a-12 and the prepreg ingredient b-2 to b-12 might counter in the same field, respectively, and so that the opposite location of the longitudinal direction in drawing 3 might shift along the thickness direction t of an antenna. And the laminating of the prepreg ingredient a-1 and a-13 was carried out all over the patch 1 side and the grand plate 2 side, respectively, subsequently to the prepreg ingredient a-1 and the outside of a-13, the laminating of the copper foil 1a and 1b was carried out, respectively, heating pressurization was carried out on 180-degreeC and 30kg/cm2 conditions, and the patch 1 and the grand plate 2 were formed. In addition, the inclination distribution length Ld of the opposite section of about 2mm and a prepreg ingredient of thickness t of this whole laminate was 60mm. In addition, after the condition of drawing 3 is completed, a garbage can be cut and can obtain the antenna of a desired geometry.

[0014] Next, the comparison result of the property of the antenna of this example and the conventional antenna is explained. In drawing 4 , Antenna A is the conventional example for which the dielectric constant epsilon used the dielectric of 3.5, and Antennas B are other conventional examples for which the dielectric constant epsilon used the dielectric of 10.5. Therefore, although Antenna B can shorten antenna length to Antenna A, radiant efficiency becomes low and bandwidth becomes narrow. In drawing 1 , using the thing of 3.5 as the 1st dielectric 4, a dielectric constant epsilon shows the case where a dielectric constant epsilon uses the thing of 10.5 as the 2nd dielectric 5, and, as for Antenna C, a dielectric constant epsilon shows the case where a dielectric constant epsilon uses the thing of 3.5 as the 2nd dielectric 5, using the thing of 10.5 as the 1st dielectric 4, in drawing 1 , as for Antenna D.

[0015] Contrary to the case of the antennas C and D as shown in drawing 1 , Antenna E moreover, the 1st dielectric 4 From the edge by the side of the feeding point Fp of patch 1 and the grand plate 2, it is formed on patch 1 so that thickness may become thin gradually toward other edges of the distance Ld direction. The 2nd dielectric 5 From the edge by

exfoliation -- it is also good to carry out the laminating easily.
[0013] Based on having the heterogeneity of specific inductive capacity as the dielectric layer 2 described above, it becomes easy to adjust [of the beam width of the radiation pattern of an antenna] the antenna equipment of the gestalt 1 of operation. For example, beam width can be made large if it is the aforementioned gestalt B in which beam width can be narrowed, it applies to the radio emission component 1 side from a conductor-layer 3 side conversely, and specific inductive capacity decreases gradually by considering as the aforementioned gestalt A in which it applies to the radio emission component 1 side from a conductor-layer 3 side, and specific inductive capacity increases gradually. Moreover, when the specific inductive capacity between layer [1st] - the n-th layer considers as the gestalt C of the above which completely changes at random, it can consider as desired beam width. With the conventional technique which is single and has moreover used the dielectric of ********** part, it is effective in the degree of freedom of the miniaturization of antenna equipment or thin-shape-izing which could not be accomplished at all improving by adopting various things as a component of a dielectric layer 2 furthermore, and being whenever [various foaming] and using it if needed.
[0014] Gestalt 2. drawing 3 of operation is the sectional view of the gestalt 2 of operation of the antenna equipment in this invention. For 1, as for a dielectric layer and 3, in drawing 3 , a radio emission component and 2 are [a conductor layer and 4] dielectric films. Although a single carries out the deer of the dielectric layer 2 and specific inductive capacity consists of one sort of a fixed dielectric which was described above, unlike the gestalt 1 of operation, the thickness of other structures is the same by the part in an uneven point. It is thin meat directly under the radio emission component 1, and the dielectric layer 2 of the other part is heavy-gage. The gaseous-phase section S exists between a dielectric layer 2 and a conductor layer 3. By carrying out thickness of a dielectric layer 2 as above-mentioned, beam width can be made large. In addition, as a deformation gestalt of the gestalt 2 of operation, with the case of the gestalt 2 of operation, it supposes that it is conversely heavy-gage directly under the radio emission component 1 of a dielectric layer 2, and if the other part is used as thin meat, it can narrow beam width.
[0015] Gestalt 3. drawing 4 of operation is the sectional view of the gestalt 3 of operation of the antenna equipment in this invention. As for a radio emission component and 2, in drawing 4 , 1 is [a dielectric layer and 3] a conductor layer and dielectric layer with 4 [another / a dielectric film and 21]. The gestalten 3 of operation differ in the point that the laminating of the dielectric layer 21 was carried out on the radio emission component 1, and are [other structures] the same. [of the gestalt 1 of said operation]
[0016] A dielectric layer 21 may be uneven identically to a dielectric layer 2 uniformly [specific inductive capacity / in / it may be constituted by different dielectric and / the direction of the thickness] like a dielectric layer 2. A dielectric layer 21 is effective in acting as a protective layer of the radio emission component 1 regardless of the class of dielectric which constitutes it. Furthermore, if it is made for specific inductive capacity to increase gradually, applying the specific inductive capacity of a dielectric layer 21 to an outside-surface side from the radio emission component 1 side like Gestalt A when the specific inductive capacity of a dielectric layer 2 is said gestalt A, a dielectric layer 21 Beam width is made still narrower, and when the specific inductive capacity of a

the side of the feeding point Fp of patch 1 and the grand plate 2, it is formed in the grand plate 2 side so that thickness may become thick gradually toward the other end of the grand plate 2. Arrangement of the two-sort dielectric of Antenna E becomes reverse, and Antenna F is formed. It can manufacture by the approach as shown in drawing 2 and drawing 3 similarly [in the case of these antennas E and F].

[0016] When the fractional bandwidth according to the antenna length L, and gain and radiant efficiency were measured using the antennas A and B of antenna C-F of the example of this invention, and the conventional single dielectric, the result as shown in drawing 5 - drawing 7 , respectively was obtained. With Antennas E and F, equivalence specific inductive capacity becomes low compared with Antennas C and D. Moreover, gain and radiant efficiency fall as compared with Antennas E and F, and, as for Antennas C and D, a band spreads. Especially, as for Antenna E, the antenna length L has the property that specific inductive capacity is equivalent to the conventional antenna A of 3.5, in 80mm or less.

[0017] That is, since gain can be improved by about 0.3-4dB by 2mm in thickness in the case of the same antenna length L, and the antenna length L can be short constituted about several mm to the conventional quarter-wave length microstrip antenna A when it is the same gain, it is effective in a pocket-size small wireless device.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is drawing showing one example of the microstrip antenna concerning this invention.

[Drawing 2] It is the explanatory view showing the manufacture approach of the microstrip antenna of drawing 1 .

[Drawing 3] It is the side elevation showing the microstrip antenna formed by the manufacture approach of drawing 2 .

[Drawing 4] It is the side elevation showing various microstrip antennas.

[Drawing 5] It is the graph which shows the fractional-bandwidth property of each antenna of drawing 4 according to antenna length.

[Drawing 6] It is the graph which shows the gain of each antenna of drawing 4 according to antenna length.

[Drawing 7] It is the graph which shows the radiant efficiency of each antenna of

drawing 4 according to antenna length.
[Description of Notations]
1 Patch
2 Grand Plate
4 Five Dielectric

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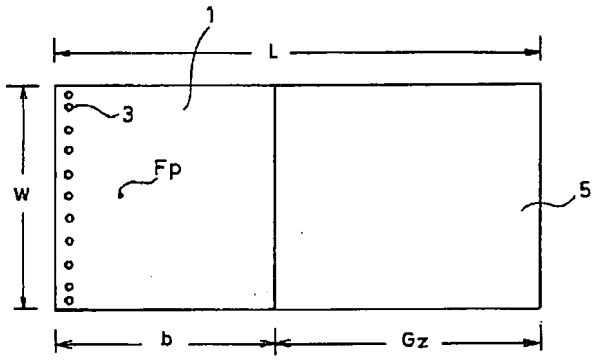
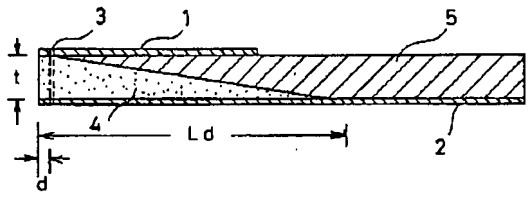
DRAWINGS

[Drawing 1]

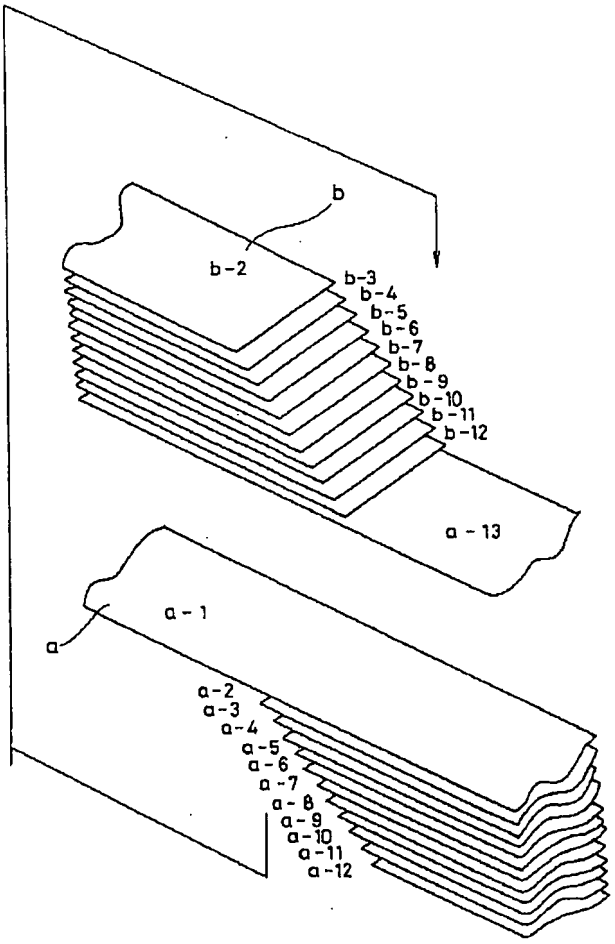
(a)



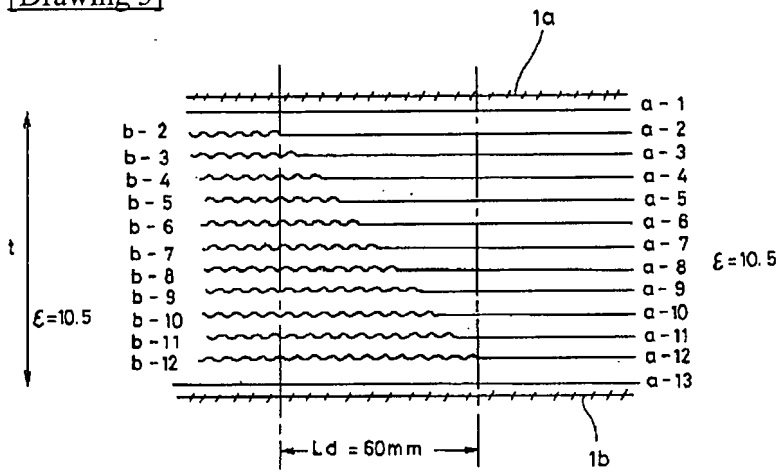
(b)



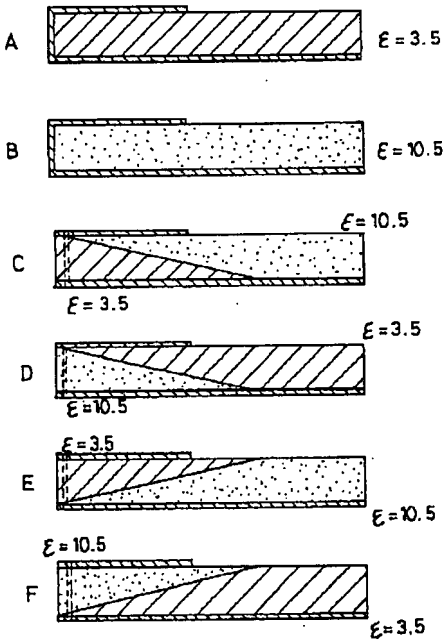
[Drawing 2]



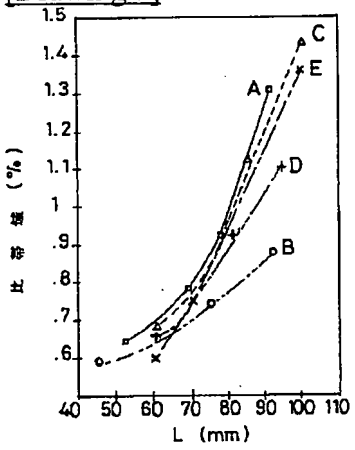
[Drawing 3]



[Drawing 4]



[Drawing 5]



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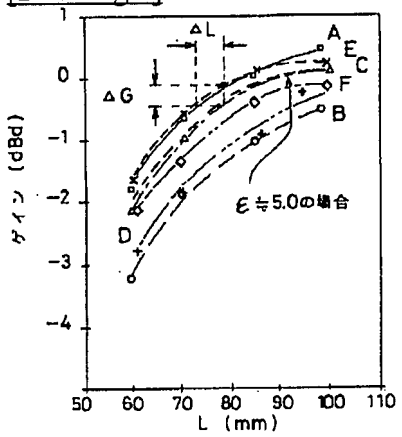

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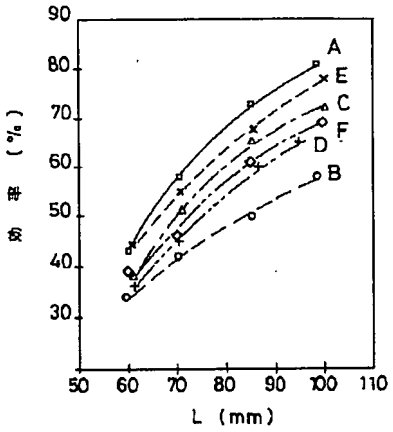
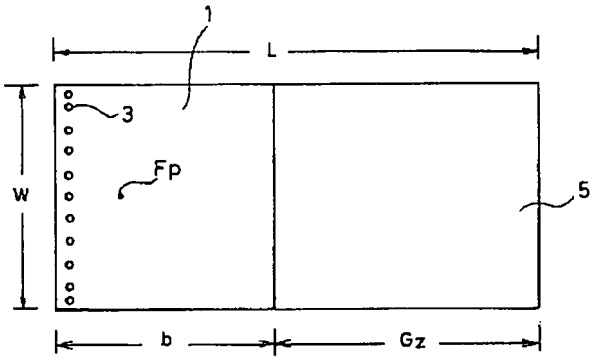


[Translation done.]

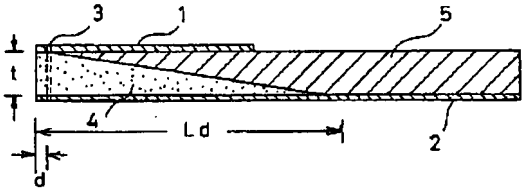
DRAWINGS

[Drawing 1]

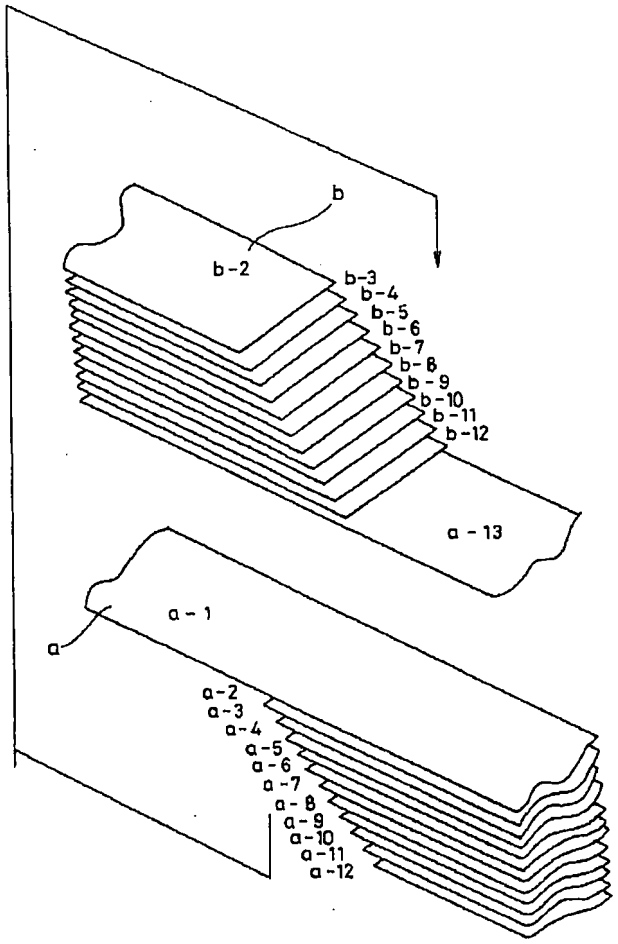
(a)



(b)



[Drawing 2]



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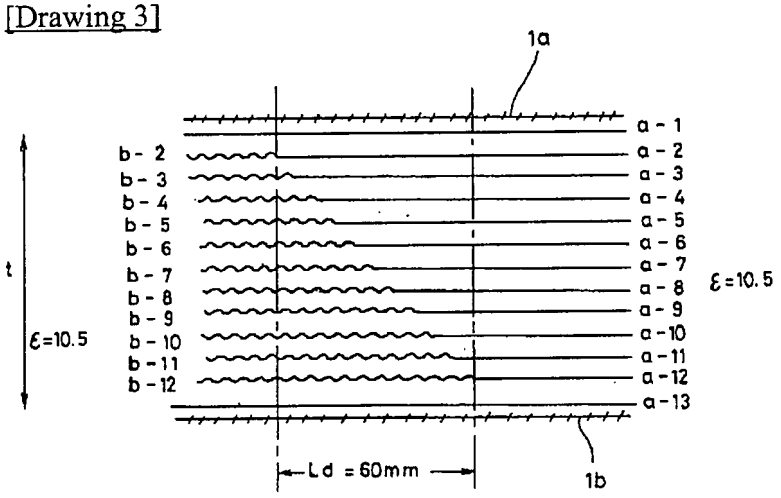

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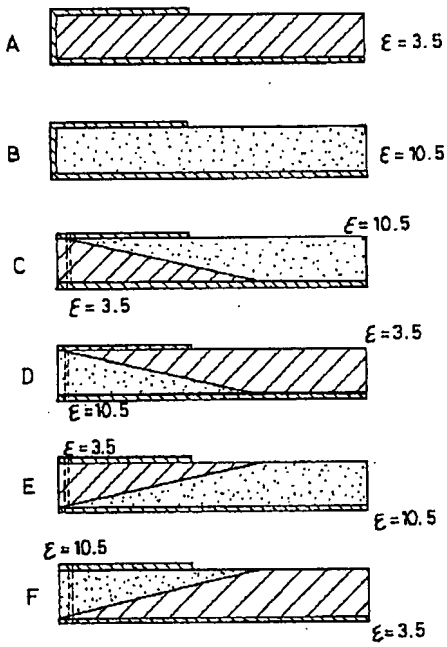

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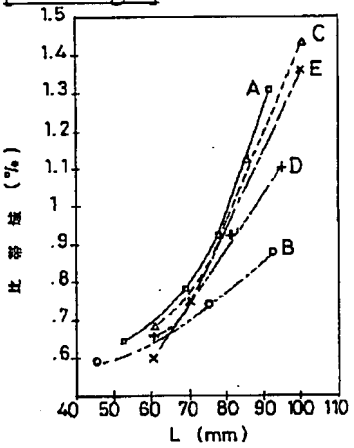

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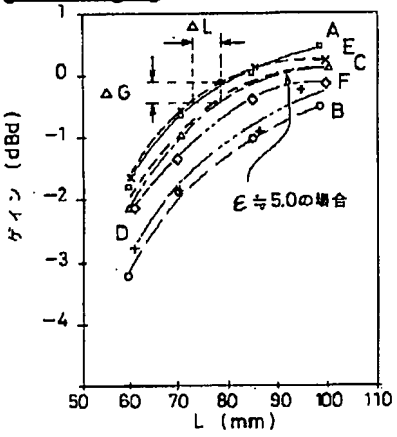
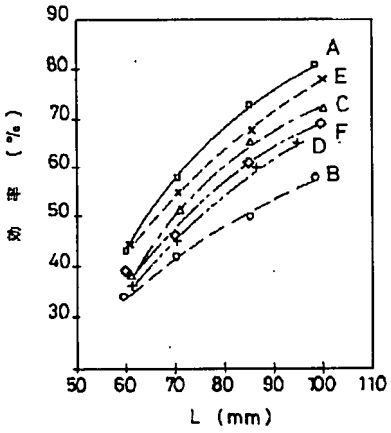


[Drawing 7]



[Translation done.]